

# NIRSpec MPT - Catalogs

Requirements to create a catalog of sources to ingest in the MSA Planning Tool within APT are discussed in detail. Candidate sets are also introduced.

## Introduction

In order to use the [MSA Planning Tool \(MPT\)](#) the user must create a catalog of objects of interest in the field to be observed. Optimal MOS spectral calibration for aperture flux loss will require catalog measurements with *high-precision relative astrometry* from an existing image. This is highly recommended but not a requirement. The MOS mode observations can be planned using astrometry with accuracies from 5-50mas. High precision spectral calibration needs relative positional accuracy of 15 milli-arcsec or less, which most likely requires space-based observations. Images obtained using HST/ACS or HST/WFC3 UVIS within the past ten years should have this level of accuracy. In some cases, the planning of the NIRSpec spectroscopy will require NIRCam observations, a process that is called [NIRCam pre-imaging](#).

This page describes the process of uploading and filtering catalogs, and defining the appropriate parameters in the **Catalogs** tab in the MPT:

- [Creating and Ingesting a Source \*Catalog\*](#)<sup>1</sup>
- [Catalog Properties](#)
- [Creating Candidate Sets](#)

### NIRSpec MPT: Catalogs, Video 1: Ingesting your *Catalog*

	<a href="#">Ingesting a parent <i>Catalog</i> in MPT</a>
	<a href="#">Ingesting a parent <i>Catalog</i> in MPT (YouTube)</a>

<sup>1</sup> ***Bold italics*** font style is used to indicate parameters, parameter values, and/or special requirements that are set in the APT GUI.

## Creating and ingesting a source *Catalog*

Parent source ***Catalogs*** can have as many objects as needed. It is recommended that parent catalogs include all known sources in the field in order to locate contaminants and prevent the MPT from placing them into failed open shutters. The type of catalog (e.g., white space or tab delineated) that is ingested must be selected in the pull-down menu in order to automatically recognize the Target ***ID***, ***RA*** and ***Dec*** columns.

Parent source ***Catalogs*** are ASCII files that must be created with these simple rules in mind:

- Two columns are required for the equatorial celestial coordinates (J2000) **RA** and **Dec** for each source. These can be expressed in units of degrees or in hexadecimal format.
- It is useful for at least one column to have the source fluxes or magnitudes (optional field).
- The catalog may optionally contain a line at the top of the file indicating column headers separated by whitespace. The line must begin with a "#".
- Other columns can be included and used by the tool for creating candidate sets if properly identified during ingest (e.g. an optional column of target weights.)

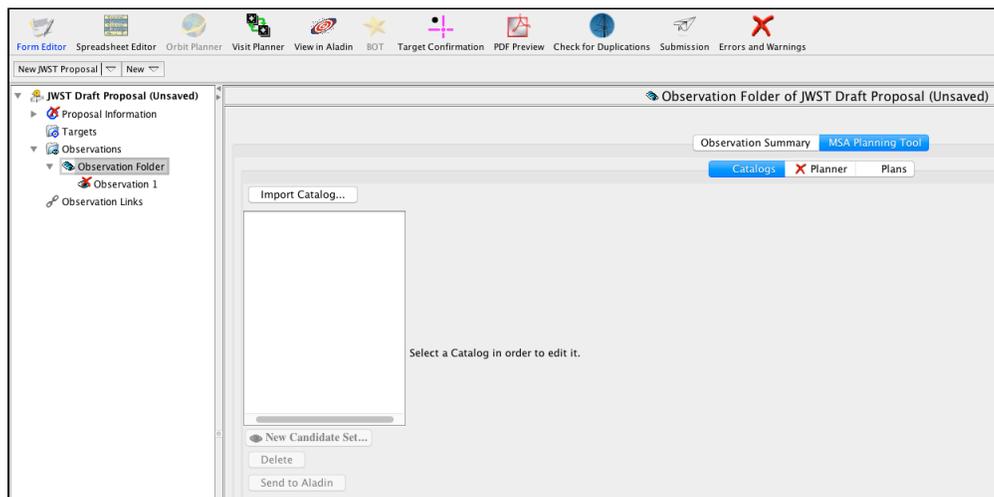
The [MPT Catalogs - Examples](#) article presents several examples to guide the user.

✔ There are some checks that should be done before ingesting your source **Catalog** into MPT. These are key to avoiding problems with MPT planning and downstream data processing. These problems are expected to be fixed in APT 26.2:

- Commas should not be present in the source **Catalog**. They are not handled correctly when ingesting the **Catalog** to MPT.
- Make sure that there are no duplicate entries in your source **IDs**. Different source positions should have a unique **ID**.
- Make sure there are no NULL entries in the columnar data in the **Catalog**. MPT may read the **Catalog** and assign a value of zero to numerical columnar data. This would be particularly problematic for a magnitude column and could result in incorrect results in the derived candidate sets made from the **Catalog**, for instance. Instead, choose value (real or integer) that can be easily filtered out.

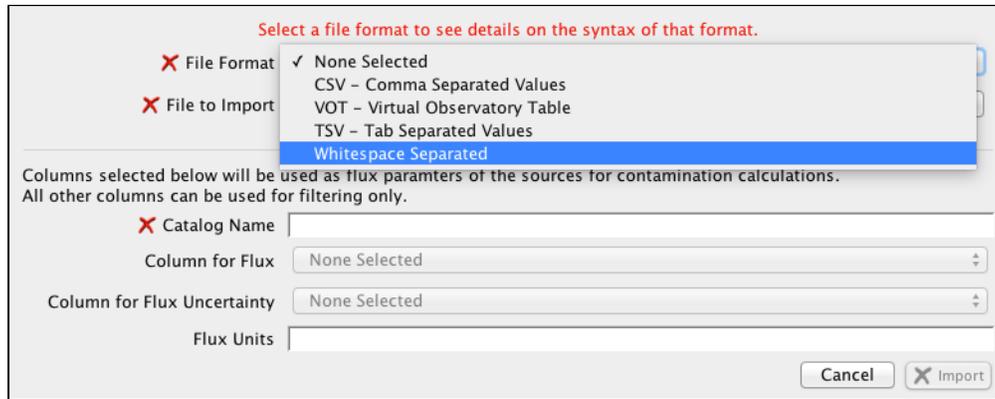
To start, make sure you are in the **Catalogs** pane of the MSA Planning Tool area of APT as shown in Figure 1. If you have trouble finding this view, you can navigate here by following the steps outlined in the article on the [MPT Guide](#). To upload a catalog, click **Import Catalog**.

**Figure 1. Importing a catalog of sources**



A pop-up window will appear for loading the *Catalog*. Several formats are allowed for the *Catalogs: comma-separated, tab-separated, white-space separated* or *Virtual Observatory (VO) Table* format as shown in Figure 2. Select the appropriate format under *File Format*. Use the *Catalog Name* space to give an appropriate name for this *Catalog*.

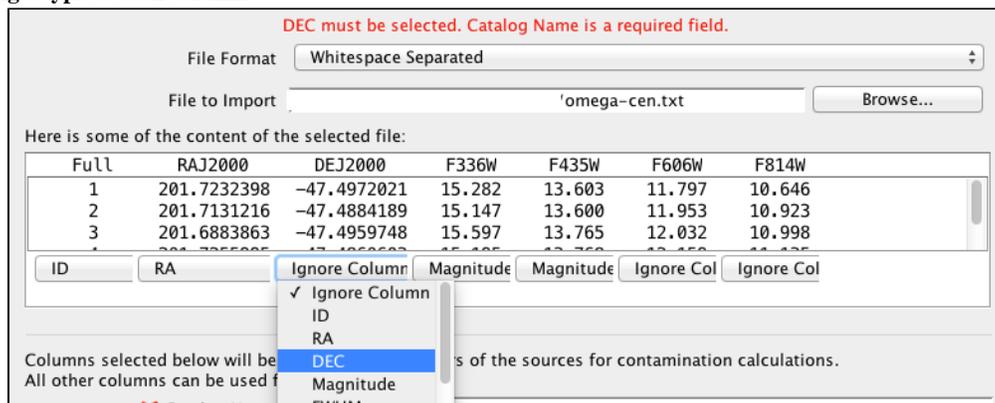
Figure 2. Selecting a File Format



During catalog ingest, MPT will attempt to auto-identify the columns if the catalog format has been selected properly. Users should check and correct the auto-assignment, and continue to assign a column type to remaining columns using the pull-down menu located below each column, as shown in Figure 3. Several useful options are available such as *Magnitude*, *Redshift* and *Source ID* number. Other available options are *FWHM*, *R50*, *Weight*, *Reference*, *FluxUncertainty*, *Number*, *Stellarity*, and *Label*. Only those columns that have been identified in this way can be used during planning. After ingest, sources can be grouped into sets for potential observation based on filters placed on these catalog columns. Use the pull down menus to select or change the heading type for each column that will be used during planning.

✔ Note: Use the column type *Number* to label a column you would like to work with in MPT that does not correspond to any other recognizable type listed.

Figure 3. Assigning a type to each column





An optional field is the **Column for Flux**. This is a pull down menu that will list all the columns that were assigned a type of **Magnitude**. Select the column that will be used for filtering a set a sources. Similarly, the optional field **Column for Flux Uncertainty** is also a pull down menu that will list columns with the type **FluxUncertainty**. Select the appropriate column here if you plan to use it for filtering. In the field **Flux Units** enter the units used; for example **ABmag, Vegamag**, etc.

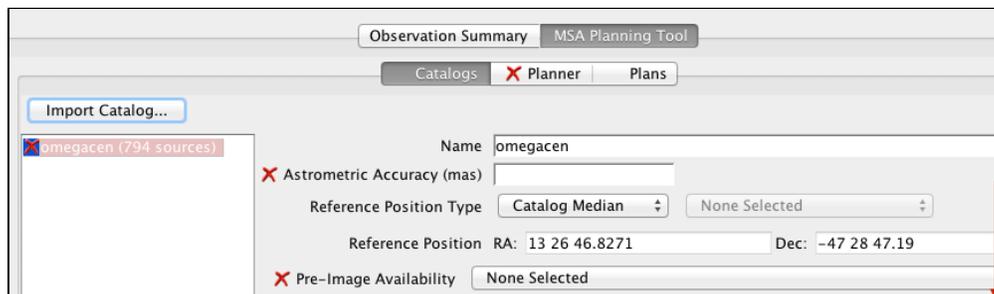
Once the **Catalog** is ingested, selecting or highlighting it will display the data as shown in Figure 4. Note that additional columns are generated (**Size, Redshift, Reference, Stellerity, and Weight**), even though they may not be in the original **Catalog**. These columns are not used if not in the original catalog, though they are auto-populated with default values (usually zeros, -1 for **Stellerity** or 1 for **Weight**). For the example shown, a total of 794 sources are listed in the catalog.

Scrollbars are present to help navigate the catalog. The **Catalog** may be sorted (in display mode only) by clicking on any column name. Columns may be reordered by dragging and dropping. The catalog will maintain its initial ordering for making an observation plan.

Weights may optionally be used by the MPT algorithms to create the final plans. In the absence of target weights, MPT will prioritize targets based on the ordering of the sources in the **Primary candidate set** (which is derived from their order in the **Catalog**), described below. If some sources in your catalog have a higher priority than others, then it is advisable to create an additional column in the catalog with weights and assign higher values to those sources. When this **Catalog** is ingested, assign the weight column as a **Weight** type. If the use of target weights is enabled in the Planner, targets with larger weights are more likely to be observed. In the example presented in Figure 4, the catalog does not have a weight column so MPT assigns the weight 1 to all sources.

✔ Note that if weights are assigned to sources, MPT will use these weights in a **linear way** when activating the use of weights in the Planner. A source with a weight of 100 will count as much as 100 sources with a weight of 1 when the tool is attempting to optimize the MSA configuration. *To further improve planning of weighted targets, it is useful to pre-order your **Catalog** by weight before ingest.* In the future, MPT will do this automatically when planning with weights.

**Figure 4. Catalog successfully loaded to the MSA Planning Tool**



ID	RA	DEC	Size	Redshift	Weight	F336W	F435W
1	13 26 53.5776	-47 29 49.93	0	0	1	15.282	13.60
2	13 26 51.1492	-47 29 18.31	0	0	1	15.147	13.60
3	13 26 45.2127	-47 29 45.51	0	0	1	15.597	13.76
4	13 26 54.1439	-47 29 9.82	0	0	1	15.195	13.76
5	13 26 45.0617	-47 30 8.06	0	0	1	15.561	13.89
6	13 26 50.4234	-47 29 23.97	0	0	1	15.420	14.04
7	13 26 47.5825	-47 28 32.67	0	0	1	15.131	13.95
8	13 26 51.5231	-47 30 39.30	0	0	1	15.612	13.71
9	13 26 45.0993	-47 28 3.12	0	0	1	14.941	13.84
10	13 26 43.6034	-47 28 39.19	0	0	1	15.114	13.93
11	13 26 48.3500	-47 30 11.14	0	0	1	15.148	13.90
12	13 26 44.8519	-47 29 4.18	0	0	1	17.005	14.80
13	13 26 39.6276	-47 28 36.26	0	0	1	15.184	14.15
14	13 26 55.1015	-47 28 35.11	0	0	1	14.927	13.97
15	13 26 37.4053	-47 28 13.84	0	0	1	15.006	14.07
16	13 26 54.1119	-47 29 44.53	0	0	1	15.226	14.28
17	13 26 45.3034	-47 30 25.45	0	0	1	15.324	14.38
18	13 26 41.8856	-47 28 46.00	0	0	1	15.018	14.14
19	13 26 52.4360	-47 29 30.85	0	0	1	15.238	13.70

Column for Flux: F814W  
Flux Units: AB

A parent Catalog as displayed in MPT. The red arrows bring attention to the scroll bars. Scroll bars are available to help users navigate the catalog. Sort the catalog in place by clicking on the column name. Reorder columns by dragging and dropping. Note that the re-ordered catalog displayed here if for convenience only, it has no effect on Catalog ordering as used in MPT to populate the MSA configurations, for example.

## Catalog properties

An **Astrometric Accuracy** in units of milli-arcsec must be specified. If a **Catalog** comes from, for example, an HST /WFC3/UVIS observation, it is safe to assign the value 10 milli-arcsec. This value is used to estimate the final accuracy of the target acquisition when using the [standard TA method](#). (Note that NIRSpec standard **TA** parameters do not need to be included in proposals).

The **Reference Position Type** allows the user to select a fiducial reference point for their observations. All pointings derived by the **Planner** in the final plan and used to create an observation will be referenced as offsets from this pointing. This information is used to determine appropriate observational plan windows. Three options are available: **Catalog Median** (default), **Fixed Target**, or **Manual Override**. They are described in Table 1. Note that this reference position can be altered or changed during the proposal planning process, but the submitted **RA** and **Dec** reference value must be the same between the proposal and the "Flight Ready Update" for accepted MOS programs.

Table 1. Description of the reference position type options

Reference Position Type	Description
<b>Catalog Median</b>	A median value for both <b>RA</b> and <b>DEC</b> are calculated based on source position in the catalog.  This option is shown as the default <b>Reference Position</b> .
<b>Fixed Target</b>	Selecting this option allows the user to select from the list of <b>Fixed Targets</b> in the <b>Targets</b> folder.

<b>Manual Override</b>	This option allows the user to define any preferred position as their observation reference pointing.
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NIRSpec MSA observations will require the most accurate relative astrometry in order to place sources in the micro shutters. For this reason, the MPT asks for the **Pre-image Availability** which has the options listed in Table 2. This information is important for pipeline processing and archiving. The reference image will be stored in the archive for later archival observers, or for more detailed program specification after an **Aperture Position Angle** has been assigned. Also, there could be an associated imaging observation in this spectroscopic program.

**Table 2. Description of the pre-imaging availability options**

Pre-image Availability	Description
<b>Is already obtained</b>	The image was already obtained using a NIRCам observation.
<b>Will be obtained external to this program</b>	The image will not be part of this proposal. For example with a new HST proposal, or an upcoming NIRCам observation in another program.
<b>Will be done in this program</b>	The user will propose to observe the same field with the JWST instrument NIRCам. In this case, two options are offered: selecting a NIRCам pre-imaging observation from the same proposal, or selecting a NIRCам coordinated parallel image attached to the program.
<b>Not required</b>	For some science programs, an image may not be available and/or isn't required. For example, precise pointing may not be needed for observing extended sources.  Use this option if you just want to experiment with MPT without getting warnings.  Use this option if there exists imaging from an HST program from the past.

## Candidate sets

Candidate sets are extracted from the supplied source **Catalog** after the catalog is loaded into MPT. Filters are applied to choose a subset of the target list based on a magnitude range, a type of source (extended vs point-like), or a redshift range, among other possibilities. Several **candidate sets** can be defined from the parent source **Catalog**.

-  Observers should be aware that they need to have all sources of interest in a single parent catalog for a given observation or a set of observations. The candidate lists (**Primary Candidate List** and **Filler Candidate List**) are derived from this single catalog. APT will prevent the creation of an observation from plans that were made with different ingested catalogs in the MPT.

### NIRSpec MPT: Catalogs, Video 2: Creating Candidate Sets 1



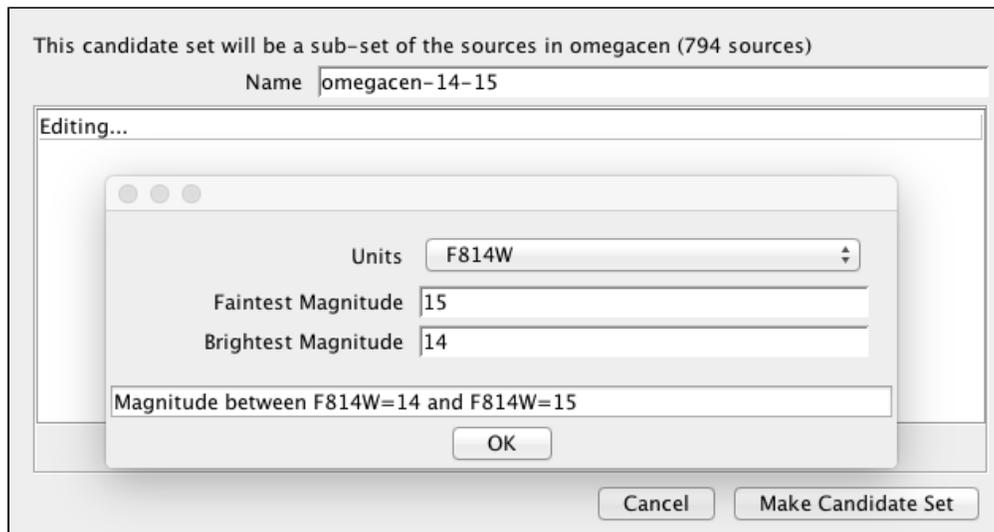
### NIRSpec MPT: Catalogs, Video 3: Creating Candidate Sets 2



By clicking on **New Candidate Set** (see Figure 4) a new window (Figure 5) is displayed. First insert a **Candidate Set Name** and begin source filtering by clicking on **Add Filter**. This button will present you with several options for filtering: **Magnitude**, **Size**, **Redshift**, **Weight**, **Number Column**, and **Script**. Define the appropriate restrictions for the candidate set, and click **OK** to close this window. Note that the ranges are always inclusive of the numbers entered. Finally, click **Make Candidate Set**.

MPT's calculations are complex and involve multiple iterations. Large source lists can result in long runtimes. The computations have been parallelized to increase efficiency, but the runtime will depend on your computer. It is advisable to experiment with smaller candidate sets to see how long it takes and then add to them as needed.

Figure 5. Creating a candidate set by filtering catalog sources



Creating a candidate set by selecting sources with magnitude F814W in the range 14 mag 15

Figure 5 demonstrates how to create a candidate set of bright sources from a given catalog. In the example shown, sources with magnitude F814W between 14 mag and 15 mag are selected as members of the candidate set. By clicking on the **Make Candidate Set** button, the new candidate set is created. As many candidate sets as needed may be created using this procedure.

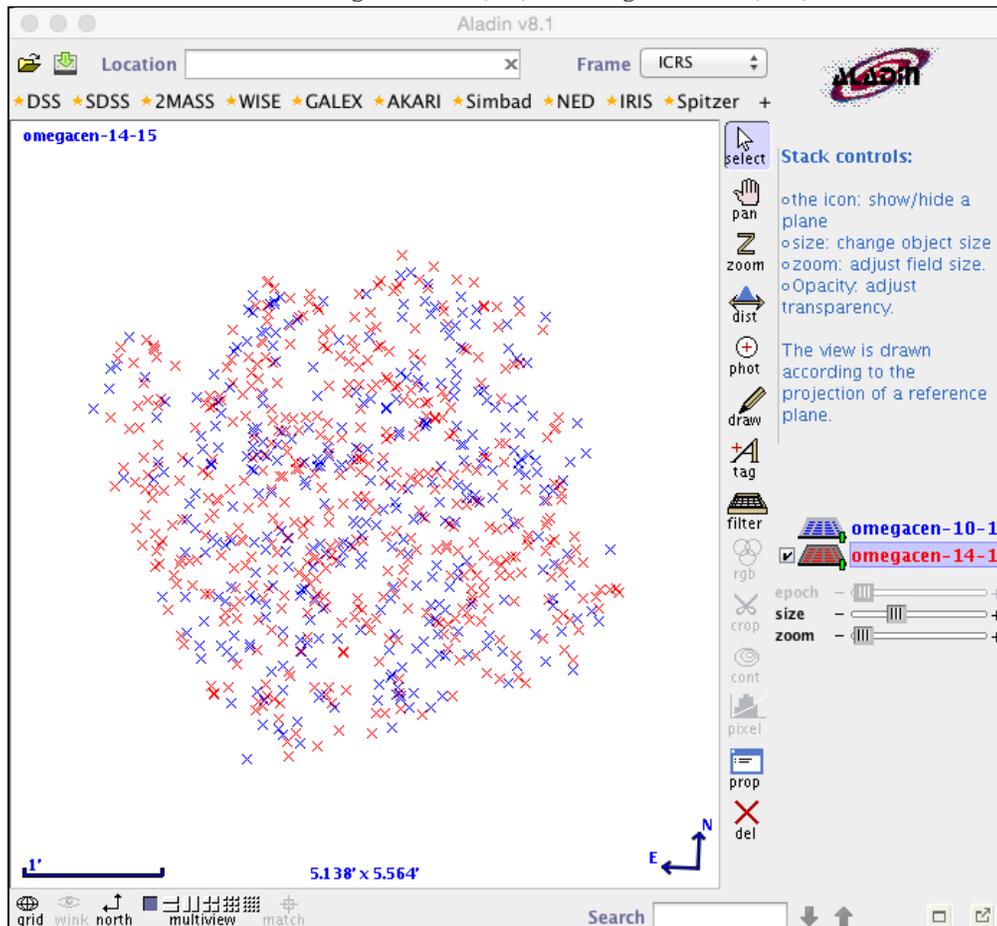
Source catalogs and candidate sets may be deleted using the **Delete** button seen in Figure 4.

⚠ Do not delete a **Catalog** if you have **Plans** in APT that were made with the **Catalog**. APT will emit a warning to remind you of this. If the warning is ignored and the **Catalog** is deleted without first deleting the affected Plans, you will not be able to save your APT file.

The **Send to Aladdin** button helps the user to visualize the spatial distribution of sources. Figure 6 shows an Aladin view of the spatial distribution of sources from two candidate sets. All the Aladin features are available and we refer the user to the [Aladin documentation](#) for further information.

✔ Having many planes in the Aladin stack can cause APT to run slowly, even after the popup is closed. To clear out all the layers, users should click **Edit > Delete All**.

Figure 6. An Aladin view of two candidate sets: omegacen-14-15 (red) and omegacen-10-14 (blue)



Once the parent source *Catalog* has been uploaded and the candidate sets have been created, the *Planner* can be used to specify a plan, as explained in the article [NIRSpec MPT - Planner](#).

## References

[Karakla, D. et al. 2014, Proc. SPIE 9149](#)

The NIRSpec MSA Planning Tool for multi-object spectroscopy with JWST

[Aladin](#)